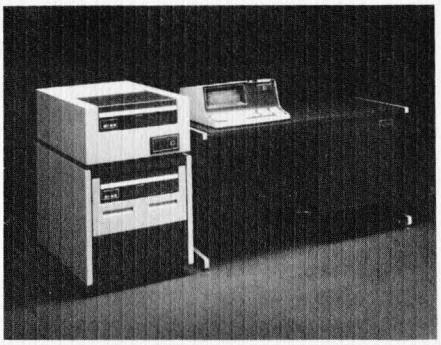
DATAPOINT CORPORATION
Product Specification

Storage Module System
9390/9391



The 9390 Storage System shown with console controller (right). 9391 Extension Drive not shown.

January 20, 1979 Document no. 60750

1.0 General Description

The Datapoint 9390 Storage Module System is a mass storage disk system intended for use with Datapoint processors which utilize DOS.D. It consists of an intelligent controller and up to three disk drives using removable multiplatter disk packs as storage media.

Each disk pack can store up to 60 Megabytes as formatted and mapped under DOS.D.

The intelligent controller is a microprocessor based design providing the interface and control functions required to attach the disk drives to Datapoint Advanced Business Processors.

The controller contains a 16K byte buffer organized as 64 pages of 256 bytes per page. The first 60 pages, numbered 0 through 59, are used for data buffering. The next three pages, numbered -- by software convention -- 252, 253, and 254, are reserved for future use. The last page, numbered 255, is used for command and status tables. It is an error to reference buffers numbered 60 through 251.

The controller verifies proper positioning of the disk Read/Write heads by reading a 4-byte header field in each sector containing cylinder, head, and sector numbers. It also appends a 6-byte Error Correction Code (ECC) to each sector data field and then checks it during reads to detect errors in the serial data (header, data, and ECC) recorded on the disk.

The ECC function is capable of detecting and correcting single error bursts up to 10 bits long. It can correct errors up to 10 bits long in its buffer before transmitting the data to the processor.

Data transfers between the Datapoint processor and the 9390 buffers can be done at any time, regardless of whether the disks are busy.

The disk drives are industry standard Storage Module Drives (SMD), with a spindle speed of 3600 RPM and a 9.677 MHz bit data transfer rate. The full formatted capacity of each physical disk pack under DOS.D is approximately 61.75 Megabytes in 785 cylinders with 312 sectors per cylinder.

The controller and its associated power supply are packaged in a console table on which the processor sits. The SMD disk drives are contained in stand-alone pedestal cabinets with one or two drives per cabinet.

2.0 System Configuration

The controller is connected to the I/O bus of the Datapoint processor via a standard I/O cable. Its assigned I/O address is 0161 octal; it can be used with any size processor memory that supports DOS.D. The controller generates and checks I/O bus parity between itself and the processor.

3.0 Technical Description

3.1 Disk Drive

The disk drive contains a removable top loading disk pack consisting of six surfaces, five of which record data while the sixth contains servo information.

Characteristics of the disk pack are as follows:

Bit Density	6038 bits/inch (inner track)
Track Density	384 tracks/inch
Model Code	80469
Bit Transfer Rate	9.677 MHz (to/from buffer)
Byte Transfer Rate	1.209 MHz (to/from buffer)

Disk timing characteristics are as follows:

Rotation	3600 RPM
Average latency time	8.33 milliseconds
Head Positioning:	
Average	30 milliseconds
Maximum	55 milliseconds

Under DOS.D, each disk pack has a capacity -- exclusive of spare tracks -- of 61.7472 Megabytes, formatted as follows:

Surfaces	5
Cylinders	785
Sectors/Cylinder	312

However, because of DOS.D mapping of logical cylinders to physical ones, not all the physical cylinders are used, hence the following:

Tracks/Cylinder	5
Sectors/Track	64
Bytes/Sector	256
Bytes/Track	16,384
Bytes/Cylinder	81,920
Bytes/Pack	60,211,200

Total DOS.D formatted and mapped capacity of two such drives in a freestanding console is 120,422,400 bytes. Total DOS.D formatted and mapped capacity of a maximum system obtained by adding the 9391 Extension is 180,633,600 bytes.

3.2 Operator Controls and Indicators

Main AC Power Switch - A two-position switch located inside the rear of the equipment cabinet, mounted on the rear of each drive. This switch controls primary AC power for the drive on which it is mounted. Operate it by pushing it up to the position marked ON.

Power Switch - A two-position switch located just to the right of the AC Power Switch inside the rear of the equipment cabinet, mounted on the rear of each drive. This switch controls

Continued...

DC power for the drive on which it is mounted. It has no effect unless the AC Power Switch has already been turned on. Operate it by pushing it up to the position marked ON.

Drive Controls and Indicators - Four operator controls and indicators for the disk drive are located on a panel on the left front face of each drive. Each control is a small square pushbutton, except the Drive Selector Key. Immediately above each control is a smaller round indicator light associated with the pushbutton. From left to right these controls are:

START Switch/indicator - When this switch is pressed, the Start cycle of the drive begins. If the drive is Ready and this switch is pressed, the Stop cycle begins.

DRIVE ASSIGNMENT Key - The Drive Assignment Key assigns a drive number (0 through 2) to the drive and provides a visual confirmation of it to the operator. The key is a small plastic probe whose flanges activate microswitches that signal the drive number. *A Drive Assignment Key must be inserted into its keyhole before a drive can come on line.* Position the key so that the number on its plastic bezel is right side up, then press the key all the way into the keyhole.

CAUTION: If the Drive Assignment key is removed from an operating drive, that drive cannot be written to or read from until the key is replaced. Change Drive Assignment keys only when a drive is off-line. It is an error, yielding undefined results, to assign the same drive number to two drives simultaneously (i.e., by using duplicate keys).

READY Indicator - The READY indicator signals the current status of the drive. When lit, the Start cycle has been completed and the drive is ready to accept external commands. At the conclusion of the Stop cycle, the indicator goes dark, signifying that the operator can load or unload a disk pack. The indicator flashes while a Start cycle or a Stop cycle is in progress.

FAULT - The indicator above this switch illuminates when any of the various possible errors have been detected by the drive. These faults require operator intervention to clear. Pressing the square switch clears the fault and turns out the fault light *if the fault condition no longer exists.* Consult Section 3.6 for a discussion of these conditions.

PROTECT Switch/Indicator - The indicator above this switch lights when the Write function has been inhibited. Pressing the square switch below the indicator activates or deactivates the write protection as desired.

3.3 Disk Pack Loading

Upper Drive (9390 and 9391)

With the START and READY indicators out, signifying that the drive may be opened, release the latch in the front center of the hydraulically assisted cover and let it rise up as far as it will go.

Lifting and holding the SMD disk pack by its handle, release its bottom cover by pressing together the two semicircular grips; remove the bottom cover. Carefully lower the SMD disk pack onto the drive spindle until it rests in position, then rotate its top cover approximately three clockwise turns to a stop. The cover will come free and may be lifted off.

Close the hydraulically assisted drive cover until you hear a sharp snap as its latch engages. Press the START switch to begin the Start cycle; the pack will reach operating speed in about seventeen seconds, and its READY indicator will stop flashing and remain lighted.

Dismounting a pack from the drive is done by the same sequence of actions in reverse order: with the READY indicator lit, press the START switch and the Stop cycle will begin, as indicated by the START light going out and the READY indicator flashing.

After about twenty-five seconds, the pack will have stopped spinning, and the READY indicator will stop flashing and remain dark. You may then release the cover latch and let the hydraulically assisted cover rise.

Hold the disk pack cover by its handle and carefully lower it over the disk pack until it will go no further; then rotate the cover approximately three full turns counter clockwise.

The entire disk pack and cover may then be lifted off the drive spindle and out of the drive. You should immediately replace the protective lower cover of the pack.

Lower Drive (9390 only)

Mounting and dismounting SMD disk packs from the lower drive in the 9390 cabinet is done exactly as described above, except that the lower drive is contained in a drawer which must slide out of the cabinet before its cover can be released and raised.

With the READY and START indicators dark, press the drawer release latches inside the grips on either side of the drawer at the bottom, and pull the drive drawer out as far as it will go. Then release the cover latch and proceed as described above.

After mounting or dismounting the SMD disk pack, close the drive cover and push the drive drawer gently back into the cabinet until both drawer release latches close.

3.4 I/O Command Set

All communication between the 9390 intelligent disk controller and the Datapoint processor is via the I/O bus using the External Command instructions and I/O register of the processor.

3.4.1 External Command Instructions

The instructions used by a Datapoint processor to control the 9390 disk system are:

Instruction	Operation
INPUT	I/O bus is loaded into I/O register
EX ADR	I/O register selects device
EX STATUS	Device status is placed on input bus
EX DATA	Device data is placed on input bus
EX WRITE	Output data is written to the device
EX COM1	Master Reset of controller
EX COM2	I/O register is loaded into controller register and device data is placed on input bus
EX COM3	I/O register is loaded into buffer page register and device data is placed on input bus
EX COM4	I/O register is loaded into byte address register and device data is placed on input bus
PIN	Like INPUT, except parity of I/O bus data is verified by the Datapoint processor
MIN	Multiple Byte Input
MOUT	Multiple Byte Output

Communication between the Datapoint processor and the 9390/9391 intelligent disk controller is performed through the command and status page -- page 255, by software convention -- of the controller buffer, as well as a hardware status byte. Therefore, most commands are issued to the 9390/9391 intelligent disk controller in the Data Mode. Disk transfers from disk to buffer or vice/versa are controlled by the 9390/9391 firmware.

Data transfers to/from the Datapoint processor can be made at any time, regardless of whether the controller is busy or not. Software must ensure that data transfers from the processor are not made to any buffer pages already allocated by a command string.

CAUTION:
The command and status page must not be

loaded with data to be written on a disk, as the firmware will attempt to interpret it as command strings. A read operation which attempts to read data from the disk into the command and status page will terminate in an error (see Command String Sense Information).

3.5 Program Interface

External commands are issued to the 9390/9391 intelligent disk controller by making entries into page 255 of its buffer. The status of commands is also maintained there.

3.5.1 EX COM1

EX COM1 is used to perform a master reset of the controller's hardware. All error status is cleared. Any drive operation in progress is terminated immediately and a RESTORE command executed, without posting any status. The firmware is reset and begins a power up sequence as if power had just been applied to the controller.

Following the EX COM1, all pages of the buffer are initialized such that any previous data is lost and the controller hardware status byte (see Section 3.6) contains the status during the power-up sequence. Pertinent bits at this time are as follows:

For "1" in Indicated Bit Position:

0 .... *MPE* - Parity error when reading from buffer.

1 ..... - Not used during POR.

2 .... *POR* - Indicates controller is doing or has done a power-on sequence.

3 .... *INS* - Installed. True when controller power is on.

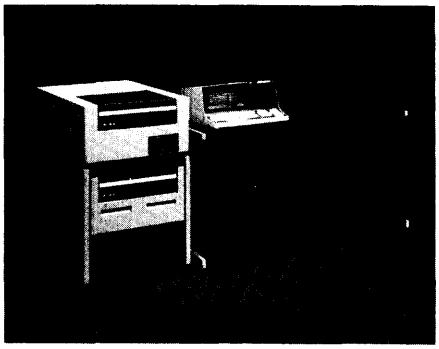
4 .... *CSS* - Control Store Scan - First step of power on sequence; tests firmware for CRC errors.

5 .... *ERR* - Error: an unrecoverable error has occurred in the controller of a type not reportable in a command string sense byte.

6 .... *RDY* - READY - Power on sequence has successfully completed.

7 ..... - Not used during POR.

When the processor sees the POR and RDY bits (2 & 6) on in the status register, the register should be reset (see EX COM2), after which the controller is again ready to accept commands. The power up sequence takes approximately 3 seconds for EX COM1 (7 seconds for power turn-on).



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3.5.2 EX COM2

EX COM2 transfers the Datapoint processor's I/O register to the controller, and puts the controller into the DATA mode. The format and definition of this byte is:

0 ..... C0
1 ..... C1
2 ..... C2
7 6 5 4 3 ..... Reserved, should be set to 0

C2 C1 C0

0 0 0 - Not Used
0 0 1 - Set 6600 Diagnostic Mode
0 1 0 - Clear Interface Status Bits
0 1 1 - Set Buffer Address to Command/Status Page, byte 255

3.5.2.1 Set 6600 Diagnostic Mode

This command places the controller in the Diagnostic Mode.

The 9390 Controller acknowledges receipt of this command by placing the Diagnostic Acknowledge (DA) bit in the hardware status byte (see Section 3.6). Set 6600 Diagnostic Mode allows the processor to perform diagnostic tests on the buffer without interference by the controller firmware.

Upon completion of diagnostic testing by the processor, an EX COM1 must be issued to return the controller to normal operational status.

3.5.2.2 Clear Interface Status Bits

This command resets the POR, RE, and MPE bits in the hardware status register.

3.5.2.3 Set Buffer Address

This command sets the buffer page address to 0377 octal (255 decimal), and the buffer byte address to 0377 octal (255 decimal). The Datapoint processor can now access the CMD Table Status Byte (see Section 3.7).

3.5.3 EX COM3

EX COM3 is used to transfer the contents of the Datapoint I/O register to the controller's buffer page register, and set the controller to DATA mode. The content of the register selects one of 60 buffer memory pages. Values 0 through 59 are valid; page 255 is always selected by EX COM2 as described above.

NOTE: Any EX COM3 issued by a program must be followed by an EX COM4 before any input in DATA mode is valid.

3.5.4 EX COM4

EX COM4 is used to transfer the contents of the Datapoint processor I/O register to the controller's buffer byte address register, and set the controller to DATA mode. The byte address register can be set to any value from 0000 thru 0377 octal (255 decimal).

The next INPUT transfers the data byte from the selected buffer address location within the currently selected page to the Datapoint processor and increments the byte address to the next location.

An EX COM2, EX COM3, or EX COM4 places the controller in DATA mode.

3.5.5 EX WRITE

EX WRITE transfers the contents of the Datapoint processor I/O register to the currently addressed buffer memory location and increments the byte address register.

3.5.6 INPUT

In Data Mode, INPUT transfers the contents of the currently addressed buffer memory location to the Datapoint processor I/O register, and increments the byte address register. In Status Mode, it transfers controller hardware status to the Datapoint processor I/O register.

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An INPUT instruction following an EX WRITE transfers the data from the buffer memory location immediately following the one written by the EX WRITE. An INPUT or EX WRITE instruction increments the buffer byte address to the next location within the current buffer page. Automatic "wrap around" from location 0377 to 0000 occurs, but the buffer page address is unchanged.

3.5.7 EX ADR

EX ADR selects the controller and places it in the Status Mode. The controller address of 0161 octal must be loaded into the Datapoint Processor I/O register prior to issuing the EX ADR command.

3.5.8 EX STATUS

EX STATUS puts the controller into the Status Mode. The next INPUT command loads the controller hardware status into the Datapoint Processor I/O register. The controller remains in STATUS mode until changed to DATA mode by a subsequent EX COM2, EX COM3, EX COM4 or EX DATA command.

3.5.9 EX DATA

EX DATA puts the controller into Data Mode for subsequent transfers between the Datapoint Processor I/O register and the controller's buffer memory using the INPUT and/or EX WRITE instructions.

3.6 STATUS

When the controller is in Status Mode, the following hardware status byte is available to the Datapoint Processor:

For "1" In Indicated Bit Position:

0 ..... *MPE* - Memory Parity Error
1 ..... *RE* - Rate Error
2 ..... *POR* - Power On Reset
3 ..... *INS* - Installed
4 ..... *CSS* - Control Store Scan
5 ..... *ERR* - Error
6 ..... *RDY* - Ready
7 ..... *DA* - Diagnostic Acknowledge

MPE - Memory Parity Error; a parity error was detected while reading data from the buffer memory. The reset is done with EX COM2, Clear Status. The operation can be retried in an attempt to recover from the error.

RE - Rate Error; indicates the buffer memory did not accept or provide data fast enough to satisfy the requirements of the Datapoint Processor. A hardware failure is indicated. Reset by EX COM2, Clear Status. Operation can be retried in an attempt to recover from this error.

POR - Power On Reset; indicates that the 9390/9391 intelligent disk controller is doing or has done a power on reset sequence. The buffer memory is initialized during the POR. It must be reset by EX COM2, Clear Status. If the bit does not reset, the power on sequence is still in progress.

INS - Installed; this bit is a logical one when the controller's power is on. It is reset by turning off power to the controller.

CSS - Control Store Scan; indicates the controller is scanning its control store (firmware) for CRC errors during a power on sequence. Reset by the firmware if the scan is completed error-free.

ERR - Error; indicates the controller has detected an unrecoverable hardware error. The controller may be unable to correctly perform one or more of its functions.

RDY - Ready; indicates the controller is ready and able to accept commands from the Datapoint Processor.

DA - Diagnostic Acknowledge; indicates the controller firmware has acknowledged the EX COM2 Set 6600 Diagnostic Mode. The controller must go through a Power On Reset (or EX COM1) sequence to recover from Diagnostic Mode (indicated by this bit being set).

3.7 Buffer Page 63

The various sections of the command and status buffer in page 63 are defined as follows:

Command Status Byte (Byte 255): Each bit of the CMD status byte refers to one of the eight command strings in the command table.

0 ..... *CS0* - Command status bit 0
1 ..... *CS1* - Command status bit 1
2 ..... *CS2* - Command status bit 2
3 ..... *CS3* - Command status bit 3
4 ..... *CS4* - Command status bit 4
5 ..... *CS5* - Command status bit 5
6 ..... *CS6* - Command status bit 6
7 ..... *CS7* - Command status bit 7

This byte is set to zero by the controller firmware during a power on sequence or after an EX COM1 command. Upon completion of a command string, the controller firmware places a 1 in the bit associated with that command string. The command status byte is addressed from the processor by issuing an EX COM2 command with the I/O register set to 0003 octal. Before it issues a new command string, the processor must check this byte to ensure that the bit associated with the previous command has changed state.

Drive Status Byte (Byte 254): The status of the currently selected drive is given by this byte, which is organized as follows:

0 ..... *WP* - Write Protected
1 ..... - Reserved
2 ..... *SELE* - Select Error
3 ..... *SERR* - Seek Error
4 ..... *OCYL* - On Cylinder
5 ..... *DRDY* - Drive Ready
6 ..... *DB* - Data Bad/Good
7 ..... *FLT* - Fault

WP - Write Protected; the selected drive has its Write Protect Switch set and its disk pack cannot be written upon. Any attempt to write on a protected drive causes the current command to terminate in an error after eight retries.

SELE - Select Error; this indicates either that more than one physical drive is responding to the address selected, or no drive responded to selection. It is set after eight retries by the firmware.

SERR - Seek Error; this bit indicates the selected drive was unable to complete a seek within 700 milliseconds, or the heads have moved to a position outside the disk recording field. SERR also sets True if an illegal cylinder number is given to the drive. This bit is set only after eight retries by the firmware.

DB - Data Bad/Good; 0 = Good Data, 1 = Bad Data in the buffer.

OCYL - On Cylinder; indicates the selected drive's servo has the heads in position over a cylinder. On Cylinder is false whenever the drive is given a seek and the heads are moving. On Cylinder also goes false during a Read Offset (+ or -) for approximately 2.75 milliseconds.

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DRDY - Drive Ready; indicates the selected drive is up to speed, heads are loaded, and no fault condition exists.

FLT - Fault; indicates the selected drive has detected a fault condition (as described in the drive specification) which firmware retries cannot clear. Fault will inhibit writing of data on the disk and reset the DRIVE READY (bit 5) status bit.

To recover from a FLT, SERR, or WP error, the software can issue a RESTORE command, then retry the command that caused the error.

Controller Sense Information (Bytes 248-252): This group of bytes is used for error reporting by the controller, and is defined as follows:

BYTE 248:

PF - Power Failure
BPE - Main Buffer Parity Error
SPE - Scratch Pad Memory Parity Error
PAI - Port A interrupt that cannot be cleared
PBI - Port B interrupt that cannot be cleared
- Reserved

BYTE 249-252: Reserved

Any of these bits set also sets the ERR bit in the controller hardware status byte (See 3.6 STATUS).

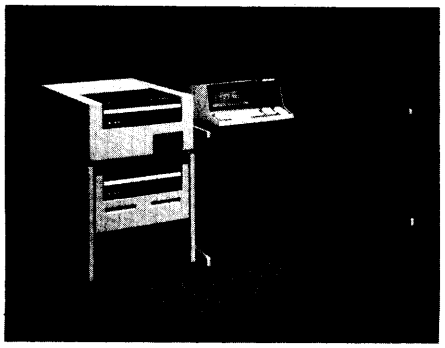
9390/9391 CONFIGURATION (Byte 240-247): This group of 8 bytes stores information concerning the type (or types) of drives attached to the controller. During the power up sequence, this section of the command and status page is dynamically loaded with a device type number (assigned to different types of disk drives) for each operational drive attached to the controller.

The 60 Megabyte, SMD Interface, Removable Media Drive is assigned device type number 1, and at present is the only device type supported by the controller.

POSITION TABLE (Bytes 96-127): The position table has a four byte entry for each drive. The byte addresses are assigned as follows:

Drive 0	Bytes 96 - 99
Drive 1	Bytes 100 - 103
Drive 2	Bytes 104 - 107
Drive 3	Bytes 108 - 111
Drive 4	Bytes 112 - 115
Drive 5	Bytes 116 - 119
Drive 6	Bytes 120 - 123
Drive 7	Bytes 124 - 127

The Position Table is used to overlap seek commands on multiple drives. Each entry is the same and organized as follows:



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Byte Numbers for Drive 0

	7	6	5	4	3	2	1	0	
96	C7	C6	C5	C4	C3	C2	C1	C0	CYLINDER
97	I	J	0	0	0	0	C9	C8	ADDRESS
98	--	--	--	--	--	--	--	--	DRIVE STATUS
99	--	--	--	--	--	--	--	--	SENSE BYTE

Cylinder Address C0 through C9: New cylinder address to seek to. The usable range is 000 through 822.

I&J - These two bits are turned on -- set to 1's --by the Datapoint processor when a new cylinder address is loaded into the position table. They serve as flags to the firmware and status to the processor indicating the state of the task. They are changed by the controller to other states according to the progress of the firmware in completing the position command. The meanings of their states are as follows:

I J

1 1 - Processor has loaded a new position request for the controller to execute, and turned these bits on.

1 0 - Position task started by controller/firmware.

0 0 - Position task successfully completed.

0 1 - Position task ended in error after 8 retries. Refer to bytes 2 and 3 for drive status and error code.

Possible transitions are: (1,1), (1,0), (0,0) for a successful completion, or (1,1), (1,0), (0,1) for an error completion.

Drive Status: This byte is the same as byte 254.

Sense Byte: This byte contains an error code which identifies the reason why the position task ended in error. The following are valid error codes for this sense byte:

Error Code	*Description*
010	Drive selection error
020	Drive dropped ready status
030	Drive fault detected
040	Seek error detected
0150	Drive not on cylinder
0240	Time out occurred while drive was processing a seek or restore command

These errors require operator or software intervention in order to attempt recovery from the error.

CMD String Sense Information (Bytes 64-95): Eight groups of four bytes are reserved for sense information. One four byte group is reserved for each of the eight command strings. The byte addresses are assigned to the command strings as follows:

CMD String 0	Bytes 64 - 67
CMD String 1	Bytes 68 - 71
CMD String 2	Bytes 72 - 75
CMD String 3	Bytes 76 - 79
CMD String 4	Bytes 80 - 83
CMD String 5	Bytes 84 - 87
CMD String 6	Bytes 88 - 91
CMD String 7	Bytes 92 - 95

Continued...

These bytes contain error information encountered while processing the given command string. Each four byte group is organized as follows:

(Byte #'s for CC0)

64	Byte 0	Drive Status (see Byte 254)
65	Byte 1	Error Code
66	Byte 2	Sector Address of multiple sector operation where error occurred.
67	Byte 3	Not used.

Error Code: The following error codes and descriptions are valid for this byte. They are divided into two catagories:

A. Recovery possible
B. Recovery impossible

Group A: These errors require operator or software intervention to attempt recovery from the error.

Error Code	*Description*
010	Drive Selection Error
020	Drive dropped Ready Status
030	Drive Fault Detected
040	Seek Error Detected
0150	Drive not on cylinder
0240	Time out occurred while drive was processing a seek or restore command.

Group B: These codes are posted following eight retries by the firmware. No system recovery is possible.

Error Code	*Description*
070	Read Error Detected (with ERP inhibited; seen only by diagnostic tests)
0110	Op error set, but no error found
0120	MDI interrupt received, but could not find why
0130	SDB Parity error found
0140	Sector overrun detected
0160	Time out occurred while waiting for the index mark in the sector counter register
0170	Time out occurred while waiting for the sector counter to increase value
0200	Time out occurred while waiting for header buffer interrupt
0210	Time out occurred while waiting for the MDI interrupt
0220	Buffer memory parity error detected
0230	Buffer memory detected a rate error
0250	Error detected while building the drive conversion tables
0260	Received MDI interrupt, while waiting for the header buffer interrupt
0270	Incorrect cylinder or head address was read off the header bytes
0300	Illegal address detected by Map Mode
0310	Sector Address not found, after full revolution of the disk
0320	Incorrect header bytes found, after the verifying routine found N-1 sector
0340	Illegal buffer address request
0350	Illegal operation of a write protected drive
0360	ECC correction performed on last command
0370	Offset (-) was used in last command

Command Table (Bytes 0-63): Eight different command strings, or operations, can be active at any one time. Commands are executed in undefined sequence. No optimization of command execution is done. The strings are assigned byte addresses as follows:

Command String 0 -- Bytes 0-7
Command String 1 -- Bytes 8-15
Command String 2 -- Bytes 16-23
Command String 3 -- Bytes 24-31
Command String 4 -- Bytes 32-39
Command String 5 -- Bytes 40-47
Command String 6 -- Bytes 48-55
Command String 7 -- Bytes 56-63

Each command string is organized as follows:

String Number	*Byte Number*								
	0	1	2	3	4	5	6	7	
0	NS0	NS1	NS2	NS3	NS4	NS5	NS6	0	Number of Sectors
1	D0	D1	D2	D3	D4	D5	MODE	MAP	Drive
2	C0	C1	C2	C3	C4	C5	C6	C7	Cylinder Addr (LSB)
3	C8	C9	0	0	0	0	0	0	
4	HD0	HD1	HD2	Res.	Res.	Res.	0	Res.	Head
5	S0	S1	S2	S3	S4	S5	0	0	Sector
6	BP0	BP1	BP2	BP3	BP4	BP5	0	0	Buffer Page
7	CM0	CM1	CM2	CM3	0	0	H	G	Command

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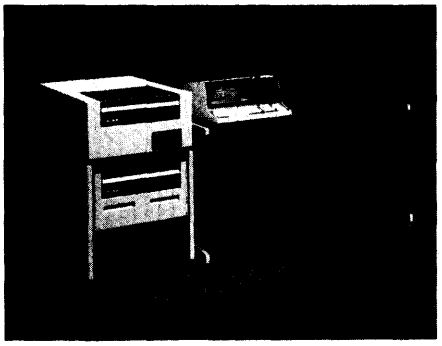

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Res.- Reserved

Byte 0

NS0 through NS6 - These bits are only used for sequential multiple sector transfers. A zero or one entry indicates a single sector transfer is to be done. The range is 0 - 60 because of buffer limits.

Byte 1

D0 through D5 - These bits are used to address one of fifteen logical or three physical disk drives.

MAP - This bit indicates whether the information in the command string is physical (MAP = 0) or logical information (MAP = 1, i.e.: Map Mode). When it is logical information, a mapping algorithm is used to get the physical drive address from the logical drive, cylinder, head, and sector addresses in the command string.

Multiple sector operations in Map Mode are allowed as long as the sectors are on one logical track. In the MAP Mode, the sectors are interlaced on the disk such that the sector to sector time is approximately one millisecond. Firmware execution time for a read or write operation is approximately 750 microseconds pre-op; 250 microseconds operation; and 75 microseconds post-op processing. Each physical disk pack is mapped to store five logical disk drives.

MODE - This bit, when set to a 1, restricts the controller from accessing (or updating) either the position table or any of the Command Strings, 1 - 7. In this mode the controller can match the timing characteristics of the 9374 disk controller, as may be required for proper operation of some time-critical software.

This bit should not be set when any position tasks -- entries in the Position Table -- or command strings 1 - 7 are active. Also note that MODE can only be cleared via an entry in Command String 0.

When the MODE bit is logical 1, only Command String 0 is polled. The Position Table and the Command Status Byte are not examined or updated. The Drive Status Byte (254) is updated.

Byte 2

C0 through C7 - These bits are the low order portion of the cylinder address.

Byte 3

C8 and C9 - These two bits are the high order portion of the cylinder address (not used in Map Mode). The combined range of bytes two and three is 0 - 1023.

Byte 4

HD0 through HD2 - These bits select which head is to be used during data transfer. The range is 0 - 7 for Mapped Mode and 0 - 4 for Unmapped Mode.

Byte 5

S0 through S5 - These bits specify the sector to be accessed during a data transfer. If it is a multiple sector transfer, this is the starting address. The range for Mapped Mode is 0 - 23 and for Unmapped Mode 0 - 63.

Byte 6

BP0 through BP5 - These bits are the binary address of the buffer page that data is to be placed into or removed from on a data transfer. On multiple sector data transfers, this is the starting page address. Page addresses cannot wrap around as the buffer numbers are not contiguous, and may not reference the command and status page. The range is 0 through 59.

Byte 7

G & H Bits - These two bits are turned on -- set to ones -- by the processor when a new command string is loaded into the command and status page. They are flags to the firmware and status to the processor indicating the state of the task. The two bits are changed by the controller to other states according to the progress of the firmware in completing this command string. The meanings of the states are as follows:

G H

1 1 Processor has loaded a new command string for the controller to execute (and turned these bits on).

1 0 Command string task started by controller/firmware.

0 0 Command string task successfully completed.

0 1 Command string task ended in error after 8 retries. Refer to Command String Sense Information for this string number to obtain the error information.

Possible transitions are: (1,1), (1,0), (0,0) for successful completion, or (1,1), (1,0), (0,1) for an error termination.

CM0 through CM3 - These bits define the command to be executed. They are defined as follows:

CM3	CM2	CM1	CM0	
0	0	0	0	NOP
0	0	0	1	READ
0	0	1	0	VERIFY
0	0	1	1	WRITE
0	1	0	0	WRITE/VERIFY
0	1	0	1	FORMAT WRITE
0	1	1	0	RESET DRIVE (RESTORE)
0	1	1	1	DRIVE SELECT
1	0	0	0	CLEAR FAULT
1	0	0	1	READ OFF (+)
1	0	1	0	SEEK
1	0	1	1	DIAG. WRITE
1	1	0	0	RESERVED
1	1	0	1	READ OFF (-)
1	1	1	0	DIAG. READ
1	1	1	1	RESERVED

Descriptions of the commands are as follows:

NOP - Can be used to change MODE of controller (from scan of CMD Strings 0 through 7 to CS0 only, or vice-versa).

Continued...

READ - Transfers 256 bytes of data from specified cylinder, head, and sector into specified buffer page. On multiple sector operations, the specified sector and buffer page are the starting addresses. The header address read from the disk is compared to the cylinder, head, and sector in the command string. Any compare failure will cause retries. The header data and ECC bytes are tested in the ECC hardware. An ECC error causes an attempt to correct the error. If unsuccessful, the read operation is retried up to eight times.

VERIFY - Same as a READ except that no data bytes are put into the buffer. Typically used to test for errors in written data.

WRITE - Transfers 256 bytes of data from specified buffer page to disk on specified cylinder, head, and sector. On multiple sector writes, the specified buffer page and sector are the starting addresses. The header and data byte are fed through a hardware ECC circuit which generates six bytes of correction code. These bytes are appended to the data byte written on the disk for use during a READ or VERIFY operation.

WRITE/VERIFY - This is a combination of the WRITE and VERIFY commands. On muliple sector operations, all writes will occur first, followed by the verifies. Typically used to immediately test for data error on the disk following the writing of data.

FORMAT - Writes a full 64 sectors of header data and ECC on specified cylinder and head. Data comes from specified buffer page. The FORMAT command must be done in UN-MAPPED mode.

RESET DRIVE - The read/write heads on the specified drive are positioned to cylinder 000. This command is issued to reset the SERR (SEEK ERROR) status bit or to ensure the heads are at a known reference position.

DRIVE SELECT - The specified drive is selected and drive status is placed in the command and status page, byte 254.

CLEAR FAULT - Clears a fault condition in the specified drive, provided the fault no longer exists.

READ OFFSET (+) - Same as READ except that the specified drive's Read/Write heads are offset from the nominal On Cylinder position toward the center of the disk pack.

When this command is completed, any Read or Write operation should be delayed at least four (4) milliseconds to give the heads time to return to their nominal position.

SEEK - The Read/Write heads of the specified drive are positioned over the specified cylinder address (and head address if in Mapped Mode). The largest physical cylinder address is 822 -- 252 in MAPPED Mode -- the smallest is 0. If a Seek fails to complete within 700 milliseconds, drive status bit 3, SERR (SEEK ERROR) is set. A Reset Drive command must be issued to reset status bit 3. More than one drive can be issued a seek command at any given time. Typical seek times are shown below:

Seek Length	*Time*
1	6 milliseconds
822 (Max)	55 milliseconds
Average	30 milliseconds

DIAGNOSTIC WRITE - Transfer 266 bytes of data from specified buffer page (overlaps into next buffer page). The first four bytes are written as header bytes, the next 256 as data bytes, and the final six bytes as ECC bytes. The data is written on the disk at the specified cylinder, head, and sector addresses. Multiple sector operations function the same as for Write command. ECC bytes are not generated and appended as for a Write command.

*** CAUTION ***

Use of this command rewrites the header and ECC bytes.

RESERVED - This command decode is for the exclusive use of 9390/9391 intelligent disk controller internal diagnostic programs. Any other use of it can cause undefined errors.

READ OFFSET (-) - Same as READ except that the specified drive's Read/Write heads are offset from the nominal On Cylinder position toward the outer edge of the disk pack. When this operation is completed, any Read or Write operation should be delayed at least four (4) milliseconds to give the heads time to return to their nominal position.

DIAGNOSTIC READ - Transfers 266 bytes (header, data, and ECC) from the specified cylinder, head, and sector into the specified buffer page. Multiple sector operations function the same as for Read command. The 266 bytes are checked by the ECC circuit.

*** CAUTION ***

Two buffer pages are used per sector. Be careful not to destroy valid data when specifying buffer page. Likewise, never specify buffer 59 for Diagnostic Read (or Write). No automatic overflow exists from buffer 59 to buffer 0.

3.8 Disk Format

The disk pack is formatted in unmapped mode with 64 sectors per track on 823 cylinders containing 5 tracks per cylinder. The format of each sector recorded on the disk pack is segmented as follows:

Fig. 3.2 - Disk Format

HEADER - 4 Bytes containing cylinder, head, and sector address for position verification.

DATA - 256 Bytes of system data.

ECC - 6 Bytes of error correction code.

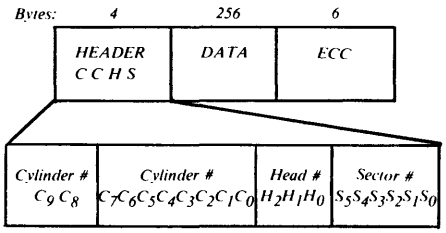


Fig. 3.2 - Disk Format

4.0 Physical Description

The 9390 consists of two drives mounted in a freestanding cabinet. The upper one can be loaded and unloaded by raising its cover. The lower drive is mounted in a drawer which must be slid out of the cabinet before its cover can be raised. The 9390 weighs appromately 567.0 pounds (257.7 kg.) A physical view is given in Figure 4-1.

Height: 36.2 inches (91.9 cm.)
Length: 22.0 inches (55.9 cm.)
Depth (total):36.0 inches (91.4 cm.)

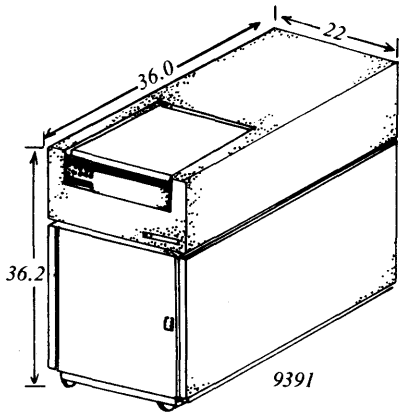
The 9391 consists of a single drive mounted in a freestanding cabinet. It has no lower drive and as a result is somewhat lighter -- 340 pounds (154.6 kg.) A physical view is given in Figure 4-1.

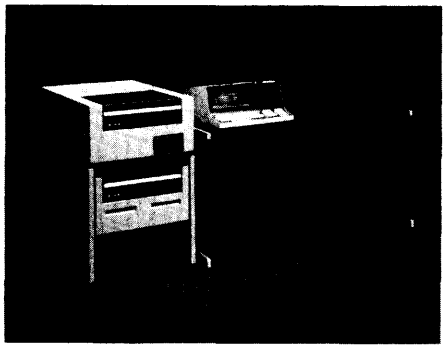
Height: 36.2 inches (91.9 cm.)
Length: 22.0 inches (55.9 cm.)
Depth (total):36.0 inches (91.4 cm.)

The 9390 intelligent disk controller is mounted in the pedestal of a console unit, the top of which is designed to accept a Datapoint processor. The disk controller and power supply, in its console, exclusive of the Datapoint processor, weighs 144 pounds (65.5 kg). A physical view of it is given in Figure 4-1.

Height: 28 inches (71.1 cm.)
Length: 53 inches (134.6 cm.)
Depth (total):27 inches (68.6 cm.)

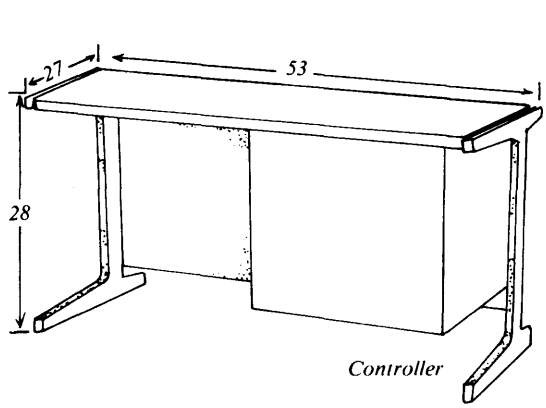
Continued...





Storage Module System

9390/9391



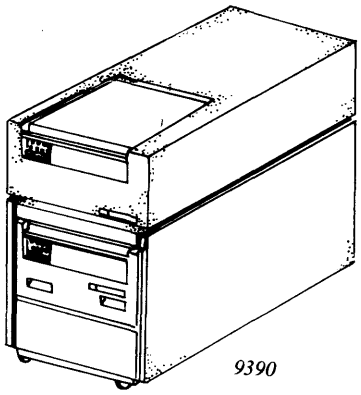


Fig. 4-1 9390/9391 Physical View

5.0 Environmental Requirements

Temperature:	60 to 90 degrees F (15 to 32 C)
Humidity:	20 to 80% relative, non-condensing
Heat dissipation:	5700 BTU/Hour, maximum for a 2-drive system + 2580 for each additional drive

6.0 Interface Requirements

6.1 Datapoint 5500/6600 Processor

The Datapoint 9390/9391 intelligent disk controller is connected to the Datapoint processor using a 42" Universal I/O Cable. The Datapoint 9390/9391 disk drive is connected to the console mounted controller using Disk Interface Cables.

6.2 Primary AC Power

Standard primary AC power requirements for the 9390/9391 are any of the following:

105 +10%/-15% VAC 60 Hz + 0.5%
110 +10%/-15% VAC 60 Hz + 0.5%
120 +10%/-15% VAC 60 Hz + 0.5%
208 +10%/-15% VAC 60 Hz + 0.5%
220 +10%/-15% VAC 60 Hz + 0.5%
105 +10%/-15% VAC 50 Hz + 0.5%
127 +10%/-15% VAC 50 Hz + 0.5%
220 +10%/-15% VAC 50 Hz + 0.5%
230 +10%/-15% VAC 50 Hz + 0.5%
240 +10%/-15% VAC 50 Hz + 0.5%

Steady state power consumption for a single drive with controller is approximately 1,270 watts. Initial power consumption during the 12-second surge when the drive is being cycled up is 2,650 watts.

Steady state power consumption for two drives with controller is approximately 1,750 watts. Initial power consumption during the 12-second surge when each drive is being cycled up is 3,400 watts.

Steady state power consumption for the maximum of three drives with controller is approximately 2,500 watts. Initial power consumption during the 12-second surge when each drive is being cycled up is 4,150 watts.

Drives are cycled up approximately 20 seconds apart to keep initial current surges at minimum. The system may be divided among several AC power circuits.

7.0 Options

7.1 Device Address

The 9390/9391 is wired at the factory for device address 0161 octal. This address may be easily changed in the field to any other valid I/O System address.

7.2 230 VAC Option

Factory-installed option 9363 is available for the 9390/9391, providing operation from 230 VAC (see 6.2). With this option, complete model codes are:

9390/9363 - Disk Drives, Freestanding, with Controller, Console, 230 VAC

9391/9363 - Extension, Freestanding, 230 VAC

8.0 Shipping List

The following items are shipped with each 9390 (removable SMD disk packs must be ordered separately).

Quantity	*Item*
1	9390 Disk System
1	Intelligent Disk Controller
1	Disk Interface Cables (set of 2)
1	9013 Universal I/O Cable (42 inch)
1	Diagnostic Program
1	9390/9391 Product Specification

The following items are shipped with each 9391 (removable SMD disk packs must be ordered separately):

Quantity	*Item*
1	9391 Disk System
1	Disk Interface Cables (set of 2)
1	9390/9391 Product Specification

**NOTE:* This shipping list is offered for information only; the current Datapoint Shipping List prevails in all cases.

DATAPOINT CORPORATION

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